

REMARKS

Prior to the present amendment, claims 9-11, 13-18, and 20-22 were pending. In the present amendment, new claims 23-28 were added, claim 16 was amended, and claims 10 and 17 were cancelled. Support for the amendments can be found throughout the specification, including page 18, second paragraph; Figure 13; and page 18, last paragraph to page 19, first paragraph. Accordingly, claims 9, 11, 13-16, 18, and 20-28 are currently pending.

Applicants thank the examiner for withdrawing the previously pending 35 U.S.C. 112, first paragraph, rejection, the 35 U.S.C. 103(a) rejection over Japan 04-206875 in view of U.S. Patent No. 5,289,038 to Amano, U.S. Patent No. 3,628,999 to Schneble, Jr. et al., and U.S. Patent No. 5,657,815 to Sugitani, and the 35 U.S.C. 103(a) rejection in view of Amano, Schneble, and further in view of U.S. Patent No. 5,245,751 to Locke, et al.

Claims Objections

Claims 10 and 17 were objected to under 37 CFR 1.75 (c) as being of improper independent form. Applicants have cancelled claims 10 and 17 herein. Accordingly, the objections have been rendered moot.

Rejections Under 35 U.S.C. §103(a)

Rejections over '875, Amano, Schneble, and Stynes

Claims 9-11 and 13-15 are rejected under 35 U.S.C. §103(a) as being unpatentable over Japan 04-206875 (" '875 ") in view of Amano (US 5,289,038), Schneble, Jr. (US 3,628,999) and Stynes (US 4,071,878). The '875 patent, Amano, and Schneble are all cited and relied as set forth in the previous Office Action. According to the examiner, Stynes discloses that a known desirable way of filling holes in electrical articles such as capacitors or circuit boards with molten metal is to provide the molten metal in a vessel (decompression chamber), reduce the

pressure in the chamber, and then lower the substrate into the molten metal, thus immersing the substrate in the molten metal, followed by pressurizing the chamber to force (flow) the molten metal into the holes (electrode regions) in the substrate, and then the substrate is withdrawn from the molten metal and allowed to cool to solidify the molten metal therein.

Pending claim 9 includes the features “forming a non-through hole which extends from a first surface toward an opposite surface of a substrate”, “forming a metal layer on the inner peripheral surface portion of the non-through hole adjacent to the first surface of the substrate, and on the portion of the first surface of the substrate adjacent to the non-through hole, such that the metal layer is directly adhered to the oxide layer” and “filling the non-through hole with molten metal by providing the molten metal in a decompression chamber, reducing the pressure into the chamber, immersing the substrate in the molten metal, and then after immersion, pressurizing the chamber so that the molten metal flows into the inside of the non-through hole”.

The '875 patent merely discloses that the hole 4 is filled with metal by inserting the metal ball 7 into the hole 4. The '875 patent does not disclose or suggest the step of “filling the non-through hole with molten metal by providing the molten metal in a decompression chamber, reducing the pressure into the chamber, immersing the substrate in the molten metal, and then after immersion, pressurizing the chamber so that the molten metal flows into the inside of the non-through hole”. As a result, in the '875 patent, since the filling method using the pressure difference between the inside and outside of the hole is not used, filling of a plating solution cannot be carried out reliably.

Amano also does not disclose or suggest the step of “filling the non-through hole with molten metal by providing the molten metal in a decompression chamber, reducing the pressure into the chamber, immersing the substrate in the molten metal, and then after immersion, pressurizing the chamber so that the molten metal flows into the inside of the non-through hole”.

As a result, in Amano, since the filling method using the pressure difference between the inside and outside of the hole is not used, filling of a plating solution cannot be carried out reliably.

Schneble does not disclose a non-through hole. Schneble does not disclose a metal layer formed on the inner peripheral surface portion of the non-through hole adjacent to the first surface of the substrate, and on the portion of the first surface of the substrate adjacent to the non-through hole, such that the metal layer is directly adhered to the oxide layer. Further, Schneble does not disclose or suggest that the step of “filling the non-through hole with molten metal by providing the molten metal in a decompression chamber, reducing the pressure into the chamber, immersing the substrate in the molten metal, and then after immersion, pressurizing the chamber so that the molten metal flows into the inside of the non-through hole”. As a result, in Schneble, since the filling method using the pressure difference between the inside and outside of the hole is not used, filling of a plating solution cannot be carried out reliably.

Stynes does not disclose a non-through hole. Further, Stynes does not disclose or suggest that “a metal layer is formed on the inner peripheral surface portion of the non-through hole adjacent to the first surface of the substrate, and on the portion of the first surface of the substrate adjacent to the non-through hole, such that the metal layer is directly adhered to the oxide layer”. In Stynes, since the both ends of the through hole open, the molten metal flows into the through hole from the both ends. Therefore, a gas inside the through hole is pushed from the both ends toward the middle of the through hole by the flowed metal so that a void is generated in the middle of the through hole. This causes a problem that the wiring is cut at the middle of the through hole. On the other hand, in the present invention, the non-through hole is filled with molten metal, that is, the molten metal flows into the non-through hole from only one end (i.e., the opened end). Since a gas inside the non-through hole is pushed to the other end (i.e., the closed end), a void is generated only in the closed end side. Therefore, the void can be easily removed in the step of removing part of the substrate such that the solidified metal is exposed

through the opposite surface of the substrate. Since Stynes does not disclose or suggest the above-described feature and effect of the present invention, there is no motivation to combine Stynes with the other citations.

Further, there is no motivation or reason to combine the citations with each other. Also, in view of the foregoing, there would be no reasonable expectation of success in combining the references.

Accordingly, the Applicant firmly believes that the present claim 9 of the present invention should be allowable since it includes the above-mentioned features which are neither disclosed nor suggested in the citations and results in the above-mentioned advantageous effects.

Furthermore, the Applicant believes that claims 11, 13 to 15, and 23 to 25 should be allowable due to at least their dependency on the allowable claim 9.

Rejections over '875, Amano, Schneble, Stynes, and Locke

Claims 16-18 and 20-22 were rejected under 35 U.S.C. 103(a) as being obvious over '875 in view of Amano, Schneble, and Stynes as applied to claims 9-11 and 13-15 and further in view of U.S. Patent No. 5,245,751 to Locke, et al. The examiner concedes that '875, Amano, Schneble, and Stynes does not disclose that (1) the hole is a through hole that extends through the work piece and that the metal filling method further comprises closing the opening of the through holes and then opening the closed opening and (2) the closing of the opening using sealing material.

The present claim 16 includes the features “a through hole which extends from a first surface toward an opposite surface of a substrate”, “forming a metal layer on the inner peripheral surface portion of the through hole adjacent to the first surface of the substrate, and on the portion of the first surface of the substrate adjacent to the through hole, such that the metal layer

is directly adhered to the oxide layer”, “closing an opening of the through hole in the opposite surface of the substrate” and “filling the through hole with molten metal by providing the molten metal in a decompression chamber, reducing the pressure into the chamber, immersing the substrate in the molten metal, and then after immersion, pressurizing the chamber so that the molten metal flows into the inside of the through hole”.

More specifically, 875' does not disclose the step of “closing an opening of the through hole in the opposite surface of the substrate”. Further, 875' does not disclose or suggest “filling the through hole with molten metal by providing the molten metal in a decompression chamber, reducing the pressure into the chamber, immersing the substrate in the molten metal, and then after immersion, pressurizing the chamber so that the molten metal flows into the inside of the through hole”. As a result, in Amano, since the filling method using the pressure difference between the inside and outside of the hole is not used, filling of a plating solution cannot be carried out reliably.

Amano does not disclose the step of “closing an opening of the through hole in the opposite surface of the substrate”. Amano also does not disclose or suggest the step of “filling the non-through hole with molten metal by providing the molten metal in a decompression chamber, reducing the pressure into the chamber, immersing the substrate in the molten metal, and then after immersion, pressurizing the chamber so that the molten metal flows into the inside of the non-through hole”. As a result, in Amano, since the filling method using the pressure difference between the inside and outside of the hole is not used, filling of a plating solution cannot be carried out reliably.

Schneble does not disclose or suggest all of the above-described features. As a result, in Schneble, since the filling method using the pressure difference between the inside and outside of the hole is not used, filling of a plating solution cannot be carried out reliably.

Stynes does not disclose or suggest that “a metal layer is formed on the inner peripheral surface portion of the non-through hole adjacent to the first surface of the substrate, and on the portion of the first surface of the substrate adjacent to the non-through hole, such that the metal layer is directly adhered to the oxide layer”. Further, Stynes does not disclose or suggest the step of “closing an opening of the through hole in the opposite surface of the substrate”. In Stynes, since the both ends of the through hole open, the molten metal flows into the through hole from the both ends. Therefore, a gas inside the through hole is pushed from the both ends toward the middle of the through hole by the flowed metal so that a void is generated in the middle of the through hole. This causes a problem that the wiring is cut at the middle of the through hole.

Locke does not disclose or suggest the step of “filling the non-through hole with molten metal by providing the molten metal in a decompression chamber, reducing the pressure into the chamber, immersing the substrate in the molten metal, and then after immersion, pressurizing the chamber so that the molten metal flows into the inside of the non-through hole. As a result, in Locke, since the filling method using the pressure difference between the inside and outside of the hole is not used, filling of a plating solution cannot be carried out reliably.

Further, there is no motivation in the citations to combine the citations with each other. Also, in view of the foregoing, there would be no reasonable expectation of success in combining the references.

Accordingly, the Applicant believes that the present claim 16 of the present invention should be allowable since it includes the above-mentioned feature which is neither disclosed nor suggested in the citations and results in the above-mentioned advantageous effects.

Furthermore, the Applicant believes that claims 18, 20 to 22, and 26 to 28 should be allowable due to at least their dependency on the allowable claim 16.

Rejections over '875, Amano, Schneble, and '191

Claims 9-11 and 13-15 were rejected under 35 U.S.C. 103(a) as being unpatentable over '875 in view of Amano, Schneble, and Japan 2002-158191 ("'191"). According to the examiner, '191 discloses a known way of filling in metal in fine pores (non through holes) in substrates is to provide a molten metal tank in a vacuum (decompression) chamber, reduce the pressure in the chamber, immerse the substrate in the molten metal tank, and then pressurizing the chamber to fill the molten metal into the pores without generating an air gap in the pores.

Applicants respectfully disagree. '191 does not disclose a metal layer formed on the inner peripheral surface portion of the non-through hole adjacent to the first surface of the substrate, and on the portion of the first surface of the substrate adjacent to the non-through hole, such that the metal layer is directly adhered to the oxide layer. As a result, in '191, since the metal layer is not previously formed on the inner peripheral surface portion of the non-through hole adjacent to the first surface of the substrate and on the portion of the first surface of the substrate adjacent to the non-through hole, a plating solution tends to leak out and filling of the plating solution cannot be carried out reliably.

'191 does not make up for the deficiencies of '875, Amano, and Schneble. Furthermore, applicants maintain that a person having ordinary skill in the art would have no reason to combine the disclosures of '875, Amano, Schneble, and '191 in order to come up with the claimed invention. Furthermore, in view of the foregoing, there would be no reasonable expectation of success in combining the references.

Reconsideration and withdrawal of the 35 U.S.C. 103(a) rejections is respectfully requested.

Applicants submit that the application is now in proper form for allowance, which action is earnestly solicited. If resolution of any remaining issue is required prior to allowance of the

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application, it is respectfully requested that the Examiner contact Applicants' attorney at the telephone number provided below.

Respectfully submitted,

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